WIRELESS LOCAL LOOP IN DEVELOPING REGIONS: IS IT TOO SOON FOR DATA? - *The case of Thailand and Kenya*

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Wireless networks are often cited as the most economically feasible solution to the severe dearth of communications infrastructure in developing countries. In the short term, the deployment of wireless networks is indeed the optimal solution to the information infrastructure gap in developing countries. Many developing nations have embarked on this road and a loose formula of employing fixed cellular networks for local loops (in the form of wireless local loop) and satellite transmission for long distance and international communications has emerged. Yet with remarkable consistency, many countries have focused solely on the installation of voice-centric networks, seemingly oblivious to the growing pervasiveness of the Internet and other data communications. Predictably, most of these countries are poor and have economies in which the overwhelming and most pressing concern is often voice communications.

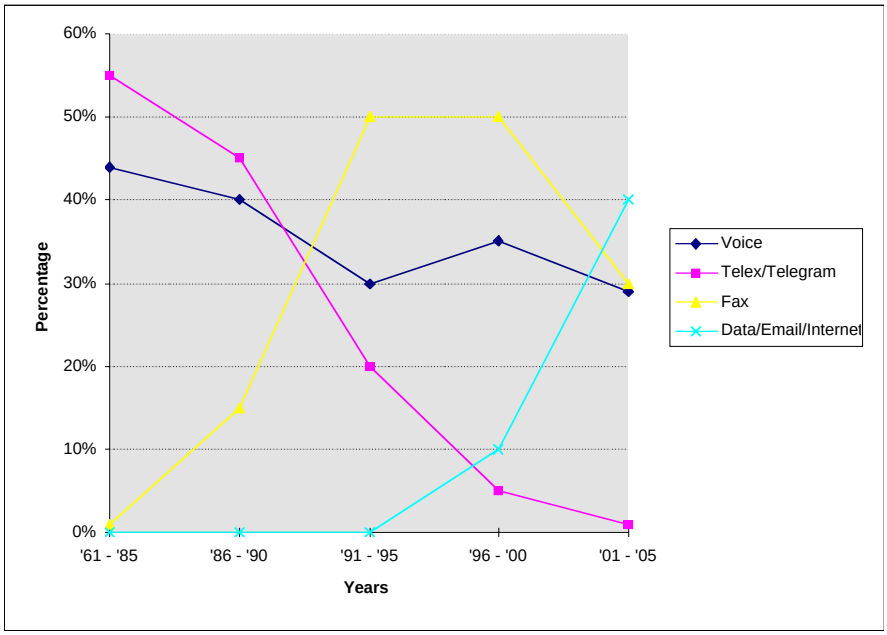
This article hypothesizes that holding out for poor economies to grow before installing data infrastructure is a sub-optimal solution which is dominated by the superior economic strategy of incorporating data communications as an integral part of the growth policies. The research results outlined in this paper will attempt to show that data communications should be just as pressing a concern as voice communications and should inform the legal, regulatory, market and spectrum policies of developing countries.

While we attempt to discuss wireless data-centric access options as they pertain to developing countries in general, Kenya and Thailand - representative of African and Asian countries respectively - will serve as case studies.

Is data communications necessary?

Arguments of this genre have been played out numerous times in several forums. We do not argue with the fact that voice communications are still the main drivers of technology in many countries today. However, it is becoming ever more evident that even the most remote regions of the world will - sooner rather than later - be forced to engage the rest of the world through various forms of communication if they are to pull themselves out of poverty and ameliorate their economies. Increasingly, the proportion of these communications which is data-oriented is dominating voice communications (see fig. 1). The era in which data will become the driver of communications is closer than many people imagine. That the developed world is leading this march should not obscure the fact that the Internet, for instance, has diffused to the rest of the world much faster than did the fax before it, which itself spread around the globe quicker than previous technologies.

Figure 1. Projected International Business Communications Traffic[1]



Ultimately, however, our goal is not to make a spirited defense of the case for data services in Kenya, Thailand, or anywhere else. Our task is simply to demonstrate the economic and functional efficiency of incorporating data capabilities in the contemporary construction of voice networks.

The Telecommunications Industry Overview in Kenya and Thailand

Although both Kenya and Thailand are categorized as developing countries, they have marked differences in the states of their telecommunication sectors, and particularly their wireless networks. Mobile cellular services in Kenya only cater to a few major cities. In fact, even wired infrastructure hardly extends beyond the confines of major urban centers, leaving much of the rest of the country - the rural areas - where a majority of the population lives bereft of adequate communications infrastructure. The attainment of universal service is, therefore, an overriding objective in Kenya. On the other hand, in Thailand where wireline based universal service has been achieved to a reasonable degree, the overriding objective - especially with regard to the deployment of wireless services - has shifted to mobility functionality above mere basic service provision. Mobile telephone networks (both analog and digital) serve all of Thailand and transmitting towers are spread all over the country. In both countries, however, little attention has been paid towards the installation of data-centric infrastructure.

Kenya

The Kenya Post and Telecommunications Corporation (KPTC) is the public telephone operator in Kenya, acting legally as the sole operator as well as regulator of telecommunications services. With the exception of Internet services (for which it is the sole provider of telephone lines) and the manufacture and sale of customer premises equipment (CPE), the KPTC literally monopolizes every aspect of the Kenyan telecommunications market.

In 1998, the Kenyan parliament enacted Acts mandating the restructuring of the KPTC into three separate entities - a telecommunications company (TELKOM KENYA), a postal corporation (POSTA) and a regulatory authority (Communications Commission of Kenya or CCK). The CCK

will regulate licensing, interconnection, "public service obligations", fair competition and operators' obligations. TELKOM will initially be wholly owned by the government. Eventually, through a series of intermediate evolutionary and incremental steps, TELKOM is envisaged to go public on the Nairobi Stock Exchange. While the Acts categorically stipulate that the introduction and fostering of competition is a major objective, the implementation plan is riddled with non-deterministic conditions and a vague timing schedule.[2]

An insidious side effect to the multiplicity of issues facing Kenya - low levels of infrastructure, a poor economy, lack of competition and low literacy rates - has been the neglect of data requirements. The natural impetus has been to simply work towards installing voice networks, since these seem more immediately required than are data services.

Thailand

In Thailand, four major laws govern the provisioning of telecommunications services, including the 1955 Radio Communications Act which authorizes the Post and Telegraph Department (PTD) to allocate and administrate frequency resources. Two other agencies, the Telephone Organization of Thailand (TOT) and the Communications Authority of Thailand (CAT) are responsible for the actual provision of telephone services (both wired and wireless).

Thailand has consistently placed great emphasis on industrial and economic development in an endeavor to migrate to a newly industrialized country (NIC) status. As a result of the urgent need to develop a telecommunications infrastructure to support economic development, there has been some relaxation of the government's control. The government has committed itself to liberalizing the industry by granting numerous concessions in order to attract telecommunications companies, which bring with them modern technology and higher quality service. Yet private operators cannot provide telecommunications services outside joint ventures with the government entities or build transfer and operate (BTO) arrangements.[3]

Wireless Technologies in Asia and Africa

There are no obvious or simple answers to the data infrastructure question. The telecommunications industry is highly dynamic, and the din from competing vendors of different technologies, very loud. Combined with the overwhelming variety of factors that must be considered, the resulting perceived risk for relatively unknown regions frightens potential investors into inaction. The temptation is to always depend on the tried and tested, sometimes with blatant disregard for the particular priorities of a region. We chose to model wireless technologies, of all the possible local access options, because they are the quickest and least expensive way to circumvent the dire lack of infrastructure.

There are several types of wireless technologies of which the main ones are satellite, wireless cable, mobile and fixed cellular, and Personal Communications Systems (PCS). In the wireless local access arena, it is mobile cellular networks that have thus far been most prolifically deployed. Several standards, both analog and digital are deployed around the world. On the other hand, there have been relatively few wireless local loop (WLL) deployments. WLL is a system that connects subscribers to the public switched telephone network (PSTN) using radio signals as a substitute for copper for all or part of the connection between the subscriber and the switch. It is a modification of the cellular system and may be based on mobile cellular, cordless or proprietary technologies. All digital WLL networks are based on either Time Division Multiple Access (TDMA) or Code Division Multiple Access (CDMA) technologies. Unlike mobile cellular, WLL is a relatively new technology. Part of the reason for this is that in developed regions, there has

been more than adequate wired local access, rendering wireless networks only commercially useful for mobility purposes. Only with recent deregulation has WLL gained popularity as a viable competitor for the local loop with incumbent operators. In developing regions where wired infrastructure is scarce, WLL promises to be a very viable alternative.

Wireless Networks in Kenya and Thailand

Table 2. Cellular and WLL networks in Kenya and Thailand[4]

Thailand	Kenya
1. NMT-470 system provided by the TOT	ETACS (analog cellular)
2. AMPS-800 (Band A) provided by the CAT	GSM (digital cellular)
3. AMPS-800 (Band B) provided by the UCOM group; concession granted by the CAT	DECT (WLL trial)
4. NMT-900 provided by the Shinawatra Group; concession granted by the TOT	PHS (WLL trial)
5. PCN-1800 provided by the UCOM group; concession granted by the CAT	CT-2 (WLL trial)
6. GSM System provided by the Shinawatra Group; concession granted by the TOT	AMPS (WLL trial)
7. PCN-1800 provided by the IEC Group	D-AMPS (WLL trial)
8. PCN-1800 provided by the Samart Group	
9. CDMA (Band A) provided by the CAT	

In Thailand, there are up to nine cellular systems in service. Of these, the first four are analog while the rest are digital. Only the first six systems have strong market positions, while the last three are still under trial or construction. In Kenya, there are two mobile cellular systems in service in the major cities. Cordless and cellular based WLL networks have recently been introduced on a trial basis and are not yet commercially available. All these systems - mobile as well as fixed - are provided by the KPTC.

The Scenarios for the Cost Models

The objective: to investigate the best routes towards the installation of networks that will in future be able to meet both data and voice requirements. The scenarios for Kenya and Thailand were different, in keeping with the two countries differing priorities - universal access for Kenya and mobility for Thailand. Although voice services are the current drivers of technology, our models anticipated a future in which data services such as full Internet access will be a crucial component of communications. The models were based on the fact that 1.) Voice only networks are in place throughout Thailand and urban parts of Kenya, and 2.) No networks at all are in place but plans to construct voice-only networks are under way in rural parts of Kenya.

The central issue facing both Kenya and Thailand is whether:
A) To continue upgrading their existing voice-centric networks (or in the case of rural Kenya, building new ones from greenfield sites) which may not meet future demand for high-speed data without costly upgrades, or
B) To immediately deploy multi-service (voice/full Internet access data compatible) installations.

Accordingly, the following cost models were developed:

Kenya
- The mobile cellular (GSM) implementation of scenario A - The current practice in much of Africa.
- WLL (Urban - proprietary, and Rural - CDMA) implementations of scenario B.

Thailand
- The mobile cellular (GSM) implementation of scenario A in Bangkok and the surrounding metropolitan areas; and
- The mobile cellular (CDMA) implementation of scenario B in Bangkok and the surrounding metropolitan areas. This scenario would facilitate a relatively inexpensive transition to high-speed data in the future.

In both countries, GSM mobile networks were modeled to represent scenario A, since as mentioned elsewhere, they are the most commonly deployed digital networks. Advanced Mobile Phone Service (AMPS) and Global System for Mobile Communications (GSM) are the most widespread cellular communications systems in developing nations, including Kenya and Thailand. Close to 89% of digital cellular networks in Africa are GSM.[5] While GSM systems can ideally support data applications up to 14.4Kbps, this speed is rarely ever achieved. Clearly in today's environment and certainly in tomorrow's 14.4Kbps would be the bare minimum required data speed, capable of sending and receiving email without large attachments or graphics. However, for major information exchange, which will include large amounts of information, graphics, charts, etc. or to browse the World Wide Web (WWW) faster data speeds will be essential.

In scenario B, different technologies were modeled for each country. For urban Kenya we proposed the deployment of a proprietary technology (using DSC Airspan as an example). DSC Airspan (DSC) is a CDMA based technology that is capable of handling data speeds of up to 128 Kbps. For rural Kenya, we modeled a fixed CDMA (IS-95B standard) cellular system. In the case of Thailand, we considered Bangkok and the surrounding metropolitan areas and proposed a CDMA mobile cellular system.

Table 3. Characteristics of the modeled networks

	GSM Mobile	CDMA Mobile	CDMA Fixed	DSC Airspan
Data speed	14.4 Kbps	13 Kbps	More than 13 Kbps	128 Kbps
Range (radius)	30 Km/ 19 miles	30 Km/ 19 miles	30 Km/ 19 miles	5 Km/ 3 miles
Technology	TDMA	CDMA	CDMA	CDMA
Mobility	Yes	Yes	None	None

In selecting the technologies to model, we not only took into consideration the data capabilities and ranges of the networks (table 3), but the likely costs of a transition to UMTS [Universal Mobile Telecommunications Service] Terrestrial Radio Access (UTRA) standards. In 1998, the

European telecommunications Standards Institute (ETSI) reached a consensus for a third generation (3G) mobile phone standard - UTRA - that draws on both wideband-CDMA (WCDMA) and CDMA2000 (formerly narrowband CDMA) proposals. WCDMA is based on a layered network-protocol structure, similar to the protocol structure used in GSM networks, while CDMA2000 is based on CDMAONE. The debate as to which will be the easiest transition - GSM to WCDMA or CDMAONE to CDMA2000 - is still raging. Nevertheless, it appears that while CDMA2000 will be backwards compatible with CDMAONE since they share the same air interface, the same will not be true for GSM and WCDMA. It will be necessary to replace all base station equipment when the shift from GSM to WCDMA occurs. The counter argument advanced by the WCDMA camp is that UTRA subscriber handsets will be dual mode and that therefore, compatibility will not be an issue. Dual mode handsets will of necessity be more complex and consequently, more expensive to construct and maintain. While the jury is still out on the issue, the switch to UTRA appears less certain for GSM than for CDMA.

While the models considered only equipment installation and maintenance costs, account was taken of technical suitability to various population densities and desired penetration levels (teledensity). Only major network cost elements were modeled.

Results of the cost models

The primary finding was that there is no significant difference in the costs of implementing any of the modeled scenarios in a given area (Table 4). Thus, for a given set of demographics, it is possible to base decisions on the suitability of particular wireless technologies purely on their functional capabilities.

Table 4a). Estimated costs per subscriber for urban Kenya[6]

	GSM Mobile	*Proprietary (e.g. DSC Airspan)*
Number of Cells	64	14
Initial Capital Costs (US$)	701	205
Operating Costs (10 years) (US$)	5195	3101
Total Costs (US$)	5896	3307
Data speed (ideal)	14.4 Kbps	128 Kbps
Range (radius)	30 Km / 19 Miles	5 Km / 3 Miles
Mobility	Yes	None

A proprietary network (e.g. DSC) would be ideally suited to urban Kenya implementations of WLL since it would provide adequate data functionality immediately. GSM's wider range would serve no advantage at all because the cost driver in a high-density urban center would be cell site capacity. The only "sacrifice" made is the mobility function. However, since universal service is a goal that dominates the need for mobility, it would appear to be an acceptable trade-off in most urban parts of Kenya.

4b). Estimated costs per subscriber for rural Kenya[6]

	GSM Mobile	*CDMA (fixed)*
Number of Cells	4	2
Initial Capital Costs (US$)	445	290
Operating Costs (10 years) (US$)	4744	4185
Total Costs (US$)	5189	4475

Data speed (ideal)	14.4 Kbps	More than 13 Kbps
Range (radius)	30 Km / 19 Miles	30 Km / 19 Miles
Mobility	Yes	None

A CDMA cellular based network would be ideal for WLL implementations in rural Kenya because of its higher capacity. Despite the higher costs of CDMA equipment, their higher capacity means that they can cover larger areas in low-density regions like rural Kenya, making their costs highly competitive. At 13 Kbps, CDMA only has marginal data capabilities, but they are sufficient to meet present day rural Kenya's requirements while preparing for a less painful shift to broadband functionality in the future. Again, the goal of universal service overrides the need for mobility.

4c). Estimated costs per subscriber in Bangkok[7]

	GSM Mobile	*CDMA (mobile)*
Initial Capital Costs (US$)	965	827
Operating Costs (10 years) (US$)	46	40
Total Costs (US$)	1011	867
Data speed (ideal)	14.4 Kbps	13/64 Kbps
Range (radius)	30 Km / 19 Miles	30 Km / 19 Miles
Mobility	Yes	Yes

Much like fixed CDMA, mobile CDMA cellular networks in Bangkok would position the city for eventual transition to broadband networks.

Conclusion

The general consensus is that data is a growing component of communications worldwide, as a consequence of which developing regions will eventually have to upgrade their infrastructure to accommodate data communications. For these poorer regions, wireless networks are a very viable option to conventional wired plant, as they are relatively inexpensive to install and maintain and are quickly deployable. The cost model demonstrates that it would be prudent to incorporate data capabilities in any new installations, and to adopt technology that will be able to easily support the shift to the next (third) generation of wireless networks. The pace at which this is done would depend on the specific circumstances of a particular country. In African countries, of which Kenya is a typical case, proprietary CDMA based networks would be very suitable for urban centers, while fixed CDMA networks would be ideal for rural areas. For urban Thailand[8], on the other hand, mobile CDMA networks may be the technology of choice.

Thus, briefly:

- data capabilities should be incorporated in any new installations
- a careful selection of technology should be made in anticipation of shift to UTRA/UMTS
- local priorities should prevail
- there should be a speedy privatization and liberalization process

The models also demonstrated that CDMA is cost competitive with TDMA. For the moment, the path from CDMA to next generation networks (IMT-2000) appears more technologically feasible than that of GSM. However, no conclusive evidence of the superiority of any particular technology has been produced.

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[1] Tunde Fafunwa, "A Failure To Connect: Africa's data communication opportunity", *ITU, 1998*

[2] Ayah, Wilson Ndolo, Minister of Transport and Communications, "Postal and Telecommunications Sector policy Statement", January, 1997

[3] Thai Telecommunications Business, Telcom Journal (Bangkok, Thailand), 1997

[4] Donyaprueth Krairit, "Mobile Communications Industry in Thailand" in Worldwide Wireless Communications. Frank Barnes (ed.) IEC Press, 1995; Ministry of Transport and Communications, Kenya

[5] African Cellular Standards, "http://www.cellular.co.za/african-standards.html", 1998

[6] "World Telecommunication Development Report, Universal Access World Telecommunication Indicators", ITU, 1998; Ministry of Transport and Communications, Kenya

[7] Thai Telecommunications Business, Telcom Journal (Bangkok, Thailand), 1997; Ministry of Transport and Communications, Kenya

[8] The results for Thailand were influenced by the lack of an explicit government policy on universal service. Were a more explicit policy to be formulated, different recommendations would result for rural Thailand.